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Future Combat Model

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Outline

- Motivation
- Discriminating Capability
- Unique Approach That Fills a Gap

Motivation

- Changing geopolitical and operational environment
- Increasing importance of C4ISR to military effectiveness
- Capabilities based analysis and use of non-traditional scenarios
- Continued problems modeling C4ISR

Changing Environment

- **Operations: Getting beyond Force-on-Force Operations to...**
 - Asymmetric Warfare by State and Non-State Actors
 - Network-Centric Operations
 - Effects-Based Operations
 - Information Operations
- **Information: Essential reliance on C4ISR**
 - Information Superiority
 - Real-Time Precision Strike
 - Dominant Battlefield Awareness
 - Sensor-to-Target
 - Perception-based decisions and implications of inaccuracies
 - Winning the fight by preventing the fight
- **Resource Planning: Breaking the Ops-Intel barrier to synchronize resourcing**
 - Demand for multi-scenario planning and sequencing
 - Capability-Based Planning



Capabilities Based Planning Paradigm



Capabilities-based planning should apportion risk across challenges

Source: OSD/Policy



The Imperative For Improvement

Current

Force on Force
Attrition Based
Individual Systems
Shooter to Target
Target-Weapon centric
Single scenario, focused Ops
Symmetric, near-peer combat
Limited treatment of C4ISR
Model based
Ignore pre crisis phases
Complex, attrition based

Needed

Information on Information
Effects Based
Families of Systems
Sensor to shooter to target
Decision Cycle centric
Multiple scenarios, broad spectrum of Ops
Asymmetric operations
Driven by information dominance
Analysis based
Driven by pre-crisis developments
Flexible, effects based

Analysts & Models are losing touch with the needs of the warfighter



FCM Version 1.0

- ✓ Explicitly models the “Road to War”
- ✓ Effects Based Planning & Operations using target/effects networks
- ✓ Hierarchical & Reactive Command & Control
- Perception (2-way) based planning
- Flexible Geographic Representation
- Innovative aggregation and abstraction supplement high value entity modeling to facilitate fast run-time and improved operational realism
- Fast run-time facilitates:
 - Quick turnaround analyses using parametric sensitivity approach
 - Fast model customization, testing, and VV&A cycles
 - Compressed analyst/decision maker feedback loop
- Stochastic, Deterministic, and Mixed modes
 - Deterministic mode allows for rapid run time & large exploratory experiments
 - Stochastic modes allow for estimation of variation and risks associated with C4ISR/operational decision making and other high leverage processes
 - Focuses use of stochastic modeling on high leverage areas (perception, planning, allocation)

Illustrative Scenario

Red Objectives:

- Control Straits of Taiwan
 - Utilize mining of key facilities
 - Position surface ships to protect forces crossing straits
- Protect forces with long range SAMs
- Utilize SOF assets to capture critical nodes and arcs
- Begin invasion with surface-to-surface missile strikes
 - Destroy enemy command and control system;
 - Cripple enemy information systems;
 - Destroy enemy's most advanced weapons systems;
 - Cripple enemy logistics systems

Blue Objectives:

- Defend Taiwan from invasion by mainland Chinese forces
- If deterrence fails, defeat attacking forces and secure long-term security of island

Limitations

- Force structure
- Basing

Response

- US deploys forces and conducts offensive operations in support of Taiwanese military

Key to success

- Adequate indications and warning which allows timely deployment of forces



Base 802715A1 (R00152) 3-01

Red Campaign Plan

• Phase 1:

- Prepare 35 Divisions (5 Heavy, 15 Medium, 15 Light) for movement to SPODS for transshipment by sea-going transports

•Phase 2:

- Move Heavy Divisions by rail to SPODS
- Prepare and position IADS, and TBM Brigades in operational locations.
- Prepare and position attack and DCA air forces in operational locations

• Phase 3:

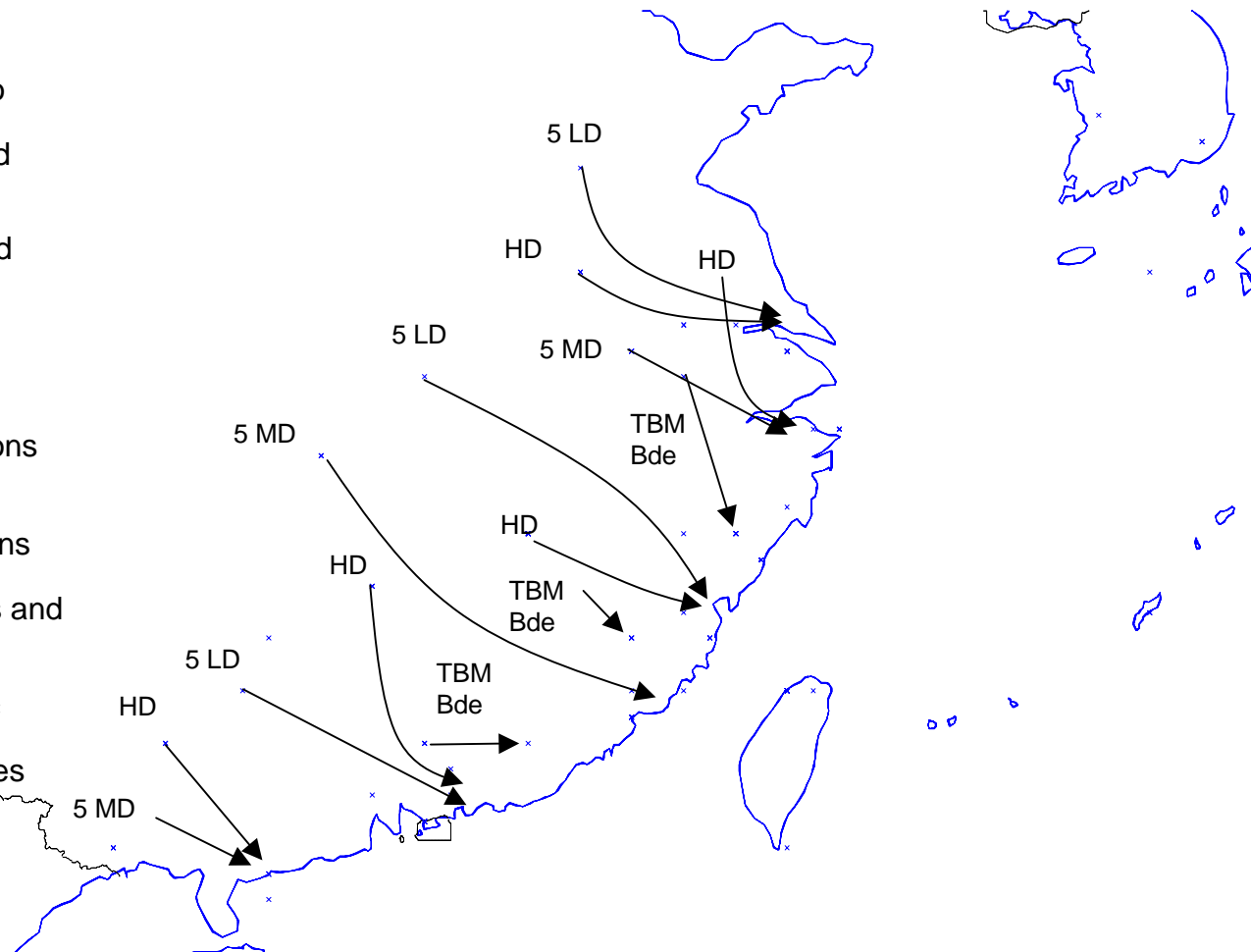
- Load Heavy Divisions onto transports
- Move Medium and Light Divisions by rail to SPODS

• Phase 4:

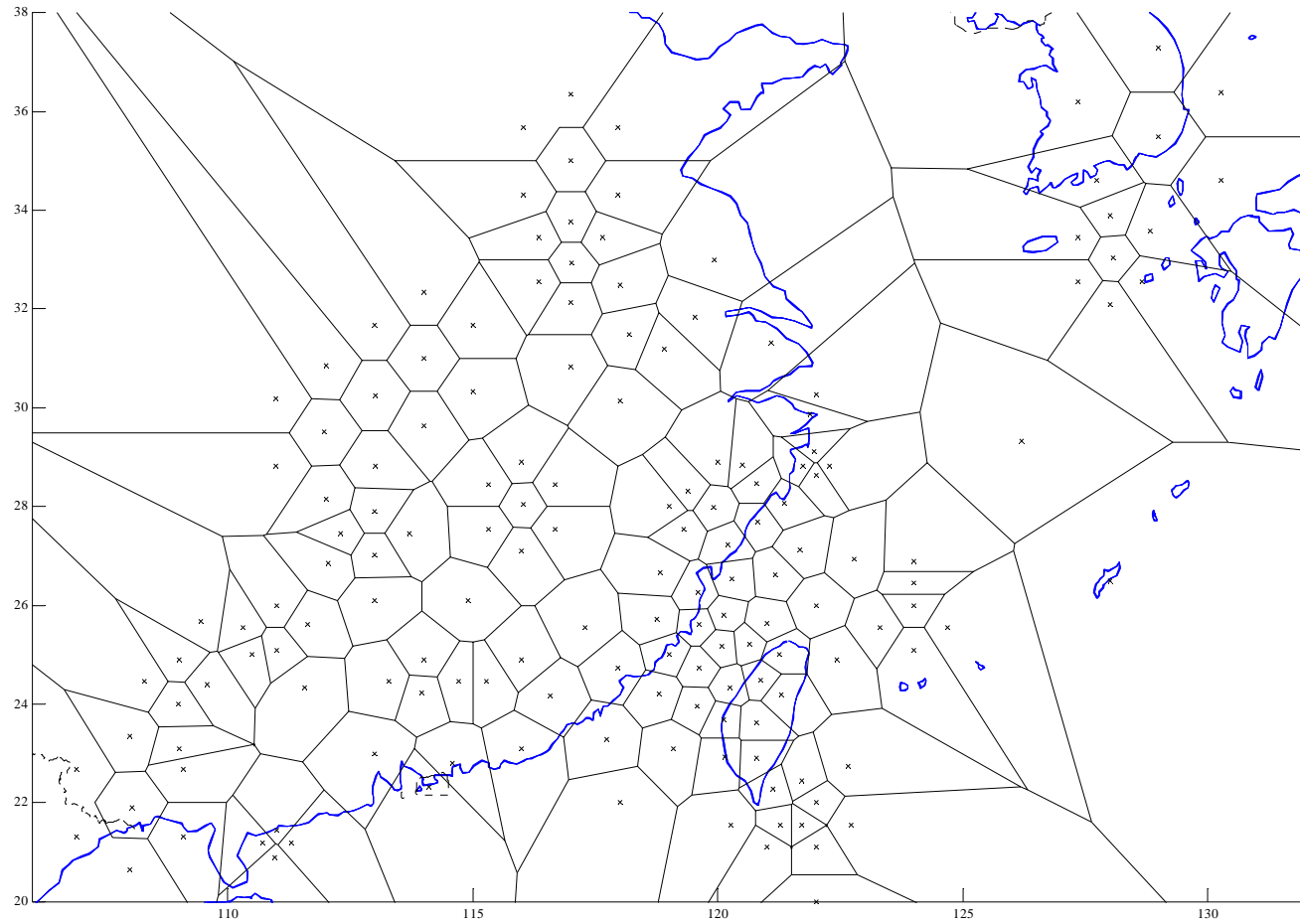
- Load Medium and Light Divisions onto transports
- Sortie transports, surface ships and submarines

• Phase 5:

- Launch TBMs against strategic targets
- Begin assault with SOF, Marines and Army Divisions



Variable Geographic Representation



C2 & “Stages”

- **Each side attempts to meet operational objectives by completing a side specific set of operational “stage orders”**
 - Stages are a set of operational orders to create operational effects and achieve desired force distributions
- **Stages are defined for pre-combat and combat phases**
 - Pre-combat stages are designed to achieve desired force positioning objectives
 - Combat stages are designed to achieve campaign objectives
 - Stages can be proactive or reactive
- **Stage progression is based on perceptions of stage progress for self and opponent**
 - Stages can be skipped
 - Stage transitions can be triggered by perception of opponent’s change in stage
- **A stage is completed when:**
 - A pre-defined fraction of asset distribution goals are met
 - Operational effects goals are met
- **Stage transition matrix**
 - Defines next stage to achieve based on own side’s current stage achieved and perceived opponent’s stage



Stage Definitions

Red Stages	Tgt Set	Airbase	SPOD	IADS	TBM Bde	Hvy Div	Med Div	Marine Div	Army Lt Div	Marine Lt Div	SubRon	DesRon	FPhibRon	FTranRon
	#	5	6	3	3	5	14	1	14	1	6	6	6	
	Day													
0	Peace	0												
1	Mob/Prep	10				Prep								
2	Initial Mob	25	Prep		Prep	Load	Prep							
3	Disperse AC	30			Deploy	Move	Load							
4	Prep Rockets	33	Operate		Prep		Move	Prep	Prep	Prep			Prep	
5	Load Amphibs	38			Deploy		Rollo	Move	Move	Move	Move	Move	Load	
6	Sortie Amphibs	45			Refuel	Sea	Sea	Load & Go	Load & Go	Load & Go			Sea	Sea
7	H Hour	47		Defend	Attack								Landing	
8	Quick Attack	45		Defend	Attack	Sea	Sea	Sea	Sea	Sea			Landing	
9	Amphibious Assault	48				Land	Land	Land	Land	Land				Landing

Blue Stages	Stage Name	Order
10	Peace	
11	Exercise Reaction	Increase ISR, move "local" CVSG to Taiwan (~3 days), alert & deploy Taiwanese forces
12	Ambiguous Warning	14+Move 2nd CVSG from Hawaii to Taiwan (~10 days), move 3rd CVSG from IO to Taiwan (~10 days)
13	Less Ambiguous Warning	15+Fly air defense caps from Japan/Korea to Taiwan, deploy B-1s and B-52s to Guam, alert rapid reaction forces (e.g. MEF & 82nd AB)
14	Unambiguous Warning	16+Deploy fighters, AWACS, etc to Japan/Korea; deploy Patriots & AA fighters to Taiwan; deploy rapid reaction forces to Taiwan; call up reserves, start mobilization of forces to theater (e.g. Japan/Korea/Taiwan)
15	Defend	17+Defend Taiwan with available forces (AA fighters, Patriots), attack Chinese ships at sea, attack Chinese IADS, C2, SPODs, APODs



Red Stage Transition Matrix

	10 Peace	11 Exercise Reaction	12 Ambiguous Warning	13 Less Ambiguous Warning	14 Unambiguous Warning	15 Active Defense
Blue Stage						
Red Stage						
0 - Peace	1	1	1	0	0	0
1 - MOB/Prep	2	2	2	2	2	0
2 - Initial MOB	3	3	3	3	3	1
3 - Disperse AC	4	4	4	4	4	2
4 - Prep Rockets	5	5	5	5	5	3
5 - Load Amphibs	6	6	6	6	6	4
6 - Sortie Amphibs	7	7	7	7	8	5
7 - H Hour	9	9	9	9	9	9
8 - Quick Attack	9	9	9	9	9	9
9 - Landing	9	9	9	9	9	9

Note: Entries in stage transition matrix indicate “Red stage ordered” based on Red’s perception of Red and Blue current stages.



Blue Reaction Orders

	10 Peace	11 Exercise Reaction	12 Ambiguous Warning	13 Less Ambiguous Warning	14 Unambiguous Warning	15 Active Defense
Blue Stage						
Red Stage						
0 - Peace	10	10	10	10	10	10
1 - MOB/Prep	11	11	11	11	11	11
2 - Initial MOB	11	11	11	11	11	11
3 - Disperse AC	12	12	12	12	12	12
4 - Prep Rockets	13	13	13	13	13	13
5 - Load Amphibs	14	14	14	14	14	14
6 - Sortie Amphibs	14	14	14	14	14	14
7 - H Hour	15	15	15	15	15	15
8 - Quick Attack	15	15	15	15	15	15
9 - Landing	15	15	15	15	15	15

Note: Entries in stage transition matrix indicate “Blue stage ordered” based on Blue’s perception of Red and Blue current stages.

Red Objective Timeline

	10 Peace	11 Exercise Reaction	12 Ambiguous Warning	13 Less Ambiguous Warning	14 Unambiguous Warning	15 Active Defense
Blue Stage						
Red Stage						
0 - Peace	0					
1 - MOB/Prep	0					
2 - Initial MOB	5					
3 - Disperse AC	13					
4 - Prep Rockets	19					
5 - Load Amphibs	36					
6 - Sortie Amphibs	43					
7 - H Hour	49					
8 - Quick Attack						
9 - Landing	50					



Situation Day 50: Red lands X Divisions on Taiwan
Blue remains in a peacetime posture, i.e.
carrier strike groups, bombers & fighters
are not deployed

Red's objective is to advance to stage 9 as soon as possible.



Blue Desired Reaction Timeline

	10 Peace	11 Exercise Reaction	12 Ambiguous Warning	13 Less Ambiguous Warning	14 Unambiguous Warning	15 Active Defense
Blue Stage						
Red Stage					Day 37	
0 - Peace	Day 0					
1 - MOB/Prep	Day 0	Day 1				
2 - Initial MOB		Day 5				
3 - Disperse AC		Day 13	Day 14			
4 - Prep Rockets			Day 19	Day 20		
5 - Load Amphibs				Day 36	Day 37	
6 - Sortie Amphibs						
7 - H Hour						
8 - Quick Attack						
9 - Landing						

Situation Day 37: Blue has completed deployment of carriers, bombers, fighters, etc to the theater.
Red backs down and cancels planned invasion

Blue's objective is to achieve unambiguous warning in sufficient time to deter aggression.

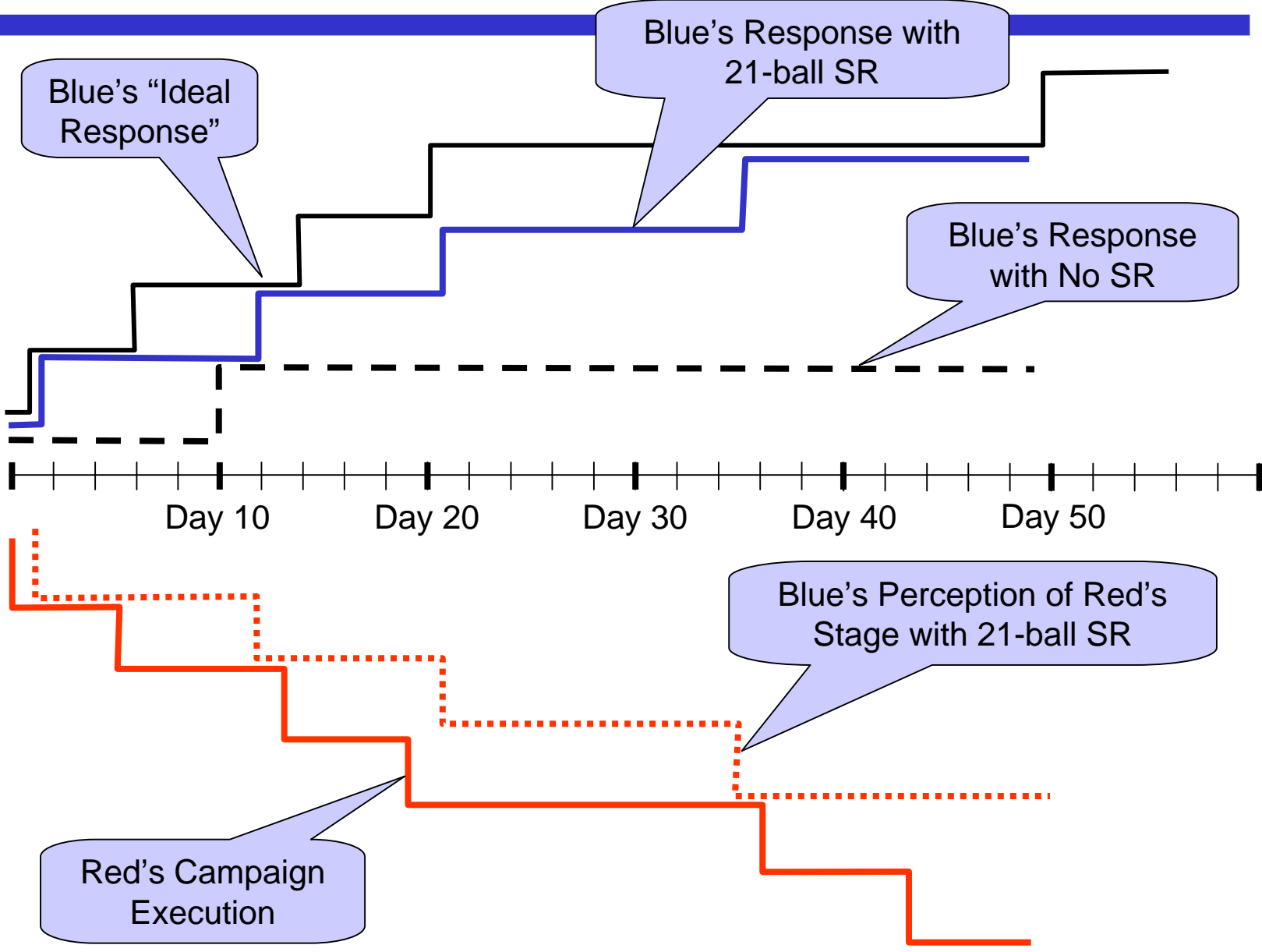
Stage Perception

- Perceptions of opponent stage conditions is driven by ISR-based observables and a Bayesian Stage Perception Model
- Observations of opponent force distributions (by cell), opponent force movement activity (within cell), and opponent effects based operations are used to determine likelihood of current stages and subsequent stages.

Illustrative Study Result

15: Active Defense
14: Unambig Warning
13 – Less Ambig Warning
12 - Ambiguous Warning
11 – Exercise Reaction
10 - Peace

0 –Peace
1 – Mob/Prep
2 – Initial Mob
3 – Disperse AC
4 – Prep Rx
5 – Load Amphibs
6 – Sortie Amphibs



Summary

- **FCM is being developed to analyze C4ISR contributions across a wide range of combat scenarios**
- **FCM is designed to incorporate:**
 - Effects Based Operations, Joint Functional Concepts and Joint Integrating Concepts
- **FCM is designed to support analyses that are responsive to decision demands and timelines**
- **FCM IOC Sept '05**

Sensor Access Approach

- **Access times will vary from hour to hour and from day to day based on pre-computed constellation simulation results (STK)**
- **Access times may vary from cell to cell depending on size of the region**
- **Multiple accesses to a cell will increase total access time in a cell; i.e. access time for an hour can exceed 60 minutes**
- **Simple rules of thumb are used to calculate imaging time from total access**
 - For Space RADAR, SAR access will be derived from SMTI access, e.g. SAR access time = $.7 * \text{SMTI access time}$
 - For space-based IMINT systems, medium and high quality time will be calculated based on low quality time, e.g. High Quality access time = $.7 * \text{Low Quality access time}$

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ISR Resource Availability

- **Utilization fraction reduces access time over theater of interest**
- **Utilization fraction represents**
 - Arrival of assets for use in theater
 - Tasking on ISR assets related to out of theater priorities
- **In-theater national tasking can be handled with explicit “background” requirements**

ISR Asset	Stage 13	Stage 14	Stage 15	Stage 16	Stage 17
	Peacetime	Exercise	Ambiguous Warning	Less Ambiguous Warning	Unambiguous Warning
Space Based Radar	0.6	0.7	0.8	0.8	0.9
Advanced Commercial Imagery	0.6	0.6	0.7	0.7	0.9
JSTARS	0.0	0.0	0.0	1.0	1.0
Global Hawk	0.0	0.0	0.0	0.0	1.0

ISR Availability Table

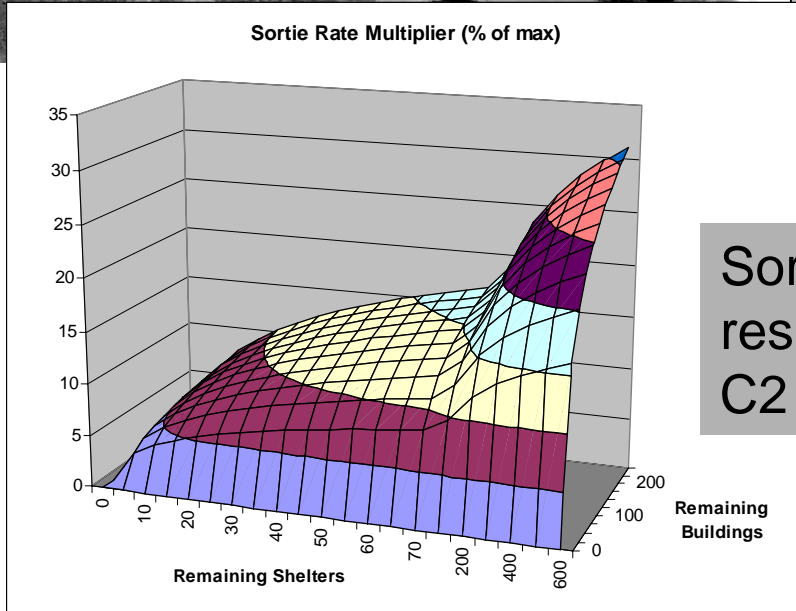
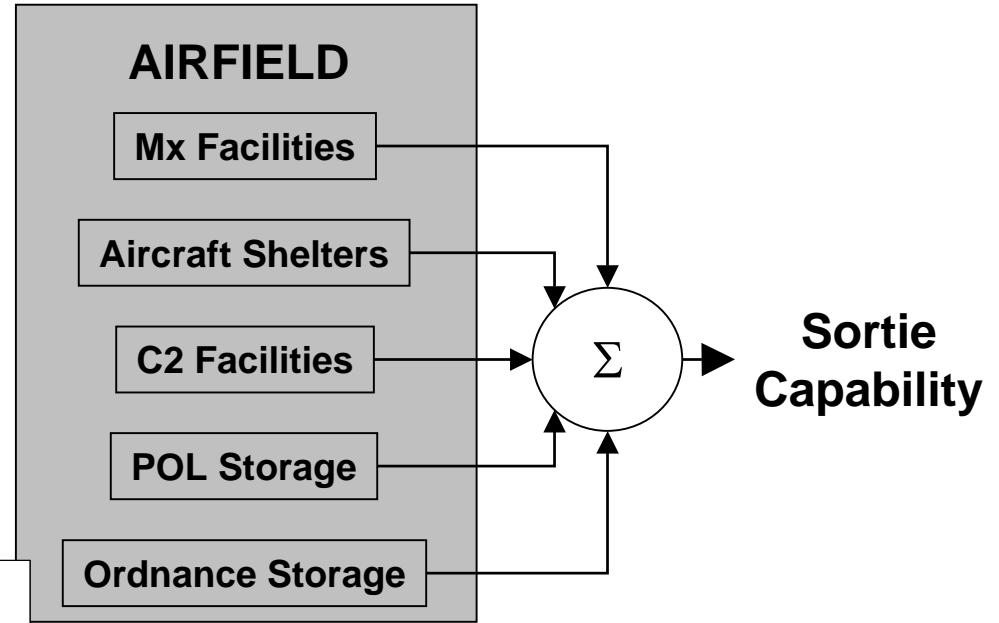
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Effects Based Operations

- **Campaign planning will be based on generating “effects” which are based on the interactions among targets.**
 - Attrition based planning is driven by a desired number of targets killed
 - Effects based planning is driven by a goal of reducing operational capabilities of operational systems by destroying elements of that system
- **“Functional Asset Sets” and capability metrics**

– Airbase	Maximum Sortie Rate
– Carrier Strike Group	Maximum Sortie Rate
– Integrated Air Defense Set	Maximum Engagement Rate
– SSM Brigade	Maximum Launch Rate
– C2 Set	C2 latency
– S&R Set	S&R capacity/timeliness
– Gnd Unit of Action	Combat Effectiveness
– Logistics Set	Units supported per day, APOD/SPOD
capacity	

Effects-Based Operations



Sortie Rate Multiplier
result with 20 out of 40
C2 nodes remaining



Perception Based Planning

- **Truth-Perception Awareness Matrices (TPAM) relate truth and perception for each asset type in each cell for each side.**
 - Cell location, kill state, ID-ness, and movement states are assumed to be “mostly independent”.
 - Target states are tracked as distributions for target aggregates within a location cell.
- **Perception is used to accomplish all planning functions.**
- **Truth determines operational outcomes**
- **The TPAM has four components**
 - Cell Location Awareness Matrix (CLAM)
 - Location Awareness Matrix (LAM)
 - Kill Awareness Matrix (KAM)
 - Identification Friend or Foe Awareness Matrix (IDAM)

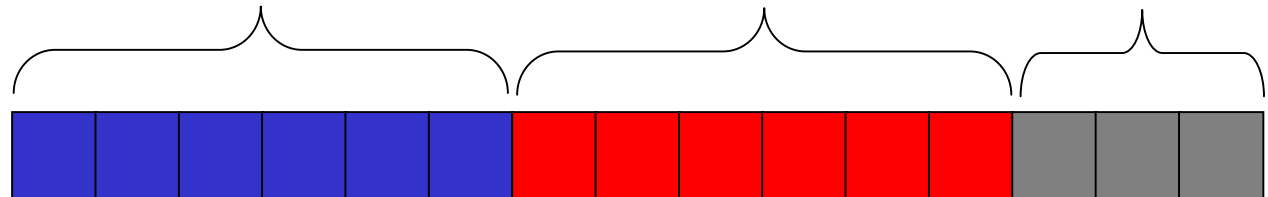
Truth-Perception Awareness Matrices

Blue Assets

Red Assets

“Neutral” Assets

Blue Perceptions



Red Perceptions



TPMs		Perception						
		Cell #1>	Cell #2>	Cell #3>	Cell #4	Undis-covered	Unaware	K
Truth	Cell #1							
	Cell #2							
	Cell #3							
	Cell #4							
	False Tgts							

- Truth and Perception are not necessarily consistent at each level of C2
- Truth Perception Matrices exist at 3 levels of C2
 - Theater
 - Component
 - Local

TPAM Structure

C2 LAM – Red Target 1

Perception

Truth		Σ	C1	C2	Undiscovered	Unaware
	C1	5/3		1	1	1
	C2	4/2	1		2	0
	False Tgt	2	1	1	0	0
	Σ		6/4	3/2	3	1

	Moving & Detected	Moving & Tracked w/ ID	Moving & Tracked w/o ID	Stopped & Imaged	Lost
Moving					1
Stopped					1
Hiding					1

C2 KAM – Red Target 1

	Σ	Alive	Indeterminate, Presumed Alive	Indeterminate, Presumed Dead	Dead
Alive	1	1	0	0	0
Dead	2	1	1	0	1

Off-diagonal Cell
C1/C2
Red Target 1

Alive/Dead

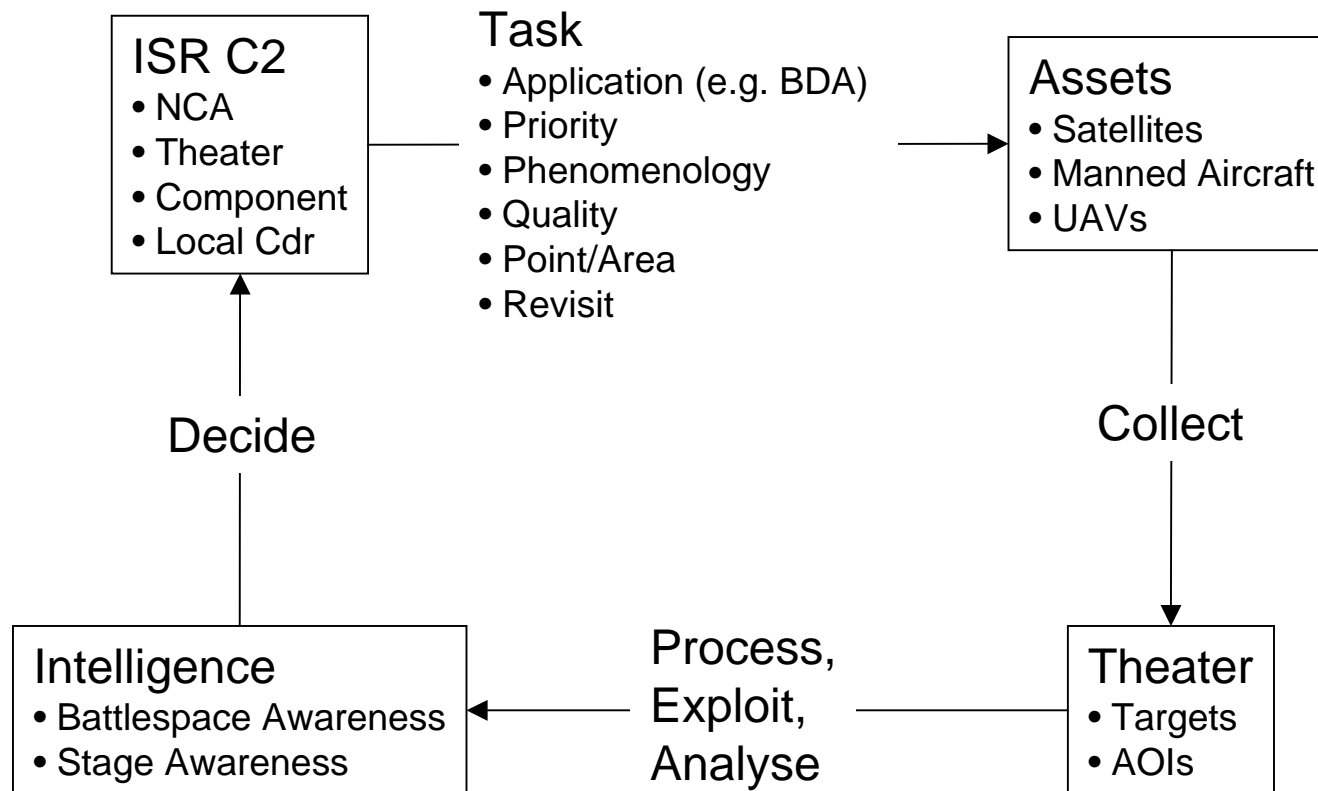
	Count
Moving	0
Stopped	1
Hiding	0
Alive	1

C2 IDAM – Red Target 1

Friendly				Neutral				Enemy				
Tgt1	Tgt2	...	TgtN	Tgt1	Tgt2	...	TgtN	Tgt1	Tgt2	...	TgtN	Σ
.05	.01	...	0	.01	.01	...	0	.7	.0501	1.00

KAM, LAM and IDAM are only defined "on the diagonal"

ISR Modeling Overview





ISR Tasks and Characteristics

- **ISR Tasks**

- Prestrike - collect image of fixed target before striking from air
- Battle Damage Assessment (BDA) - assess target health after striking from air
- Mobile Target Reconnaissance – search for lost targets and confirm location/identity of previously located targets
- Area Reconnaissance – search for undiscovered mobile targets
- Area Surveillance – monitor known areas of interest with imagery
- Monitor Mobile Targets- monitor known areas of interest with SMTI
- Tracking – maintain location of target while it is moving with SMTI

- **Priority**

- 1, 2, 3

- **Phenomenology/Quality**

- EO/IR; Low, Med, High
- SAR; Low, Med, High
- SMTI (w/ or w/out ID)

- **Image Size**

- Point
- Area

- **Revisit Rate**



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